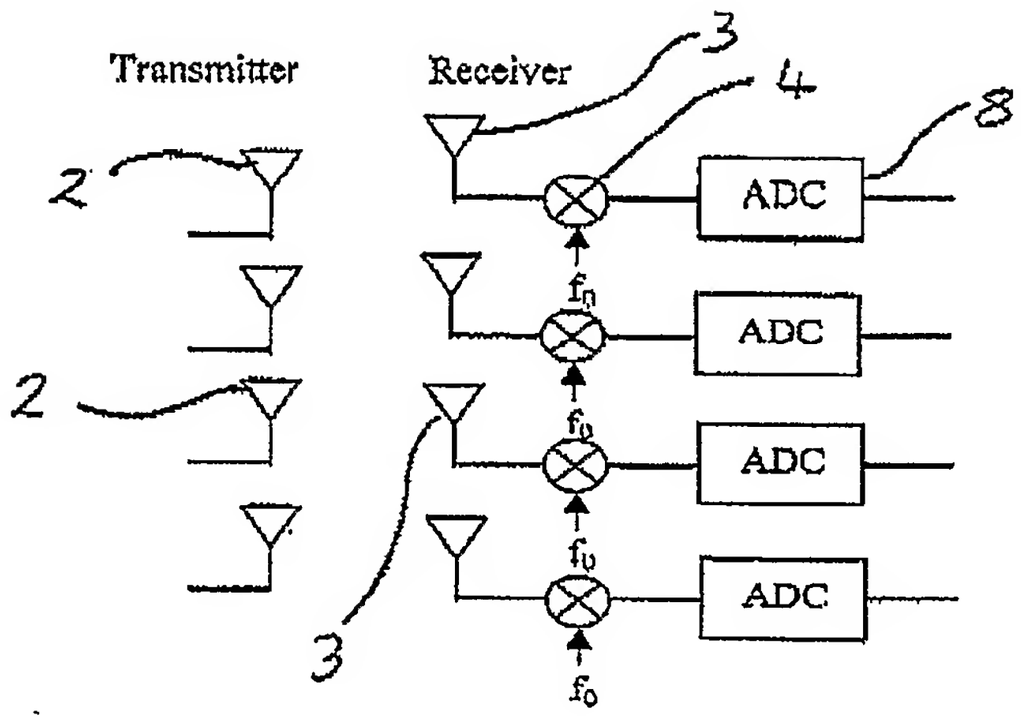

Fig. 1

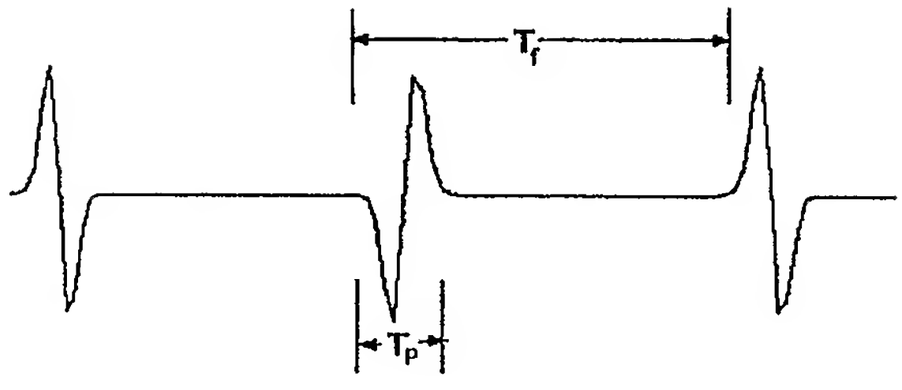

Fig. 2(a)

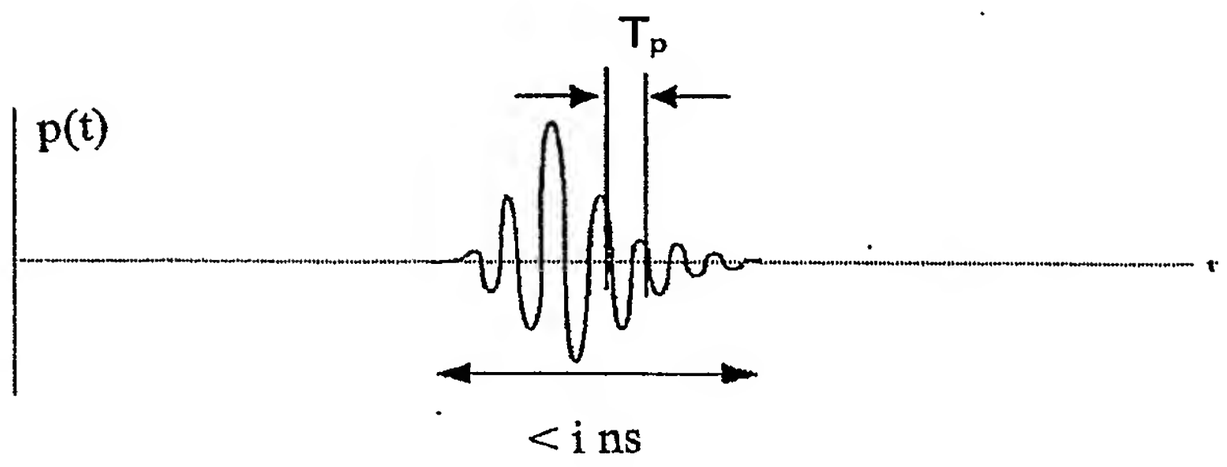

Fig. 2(b)

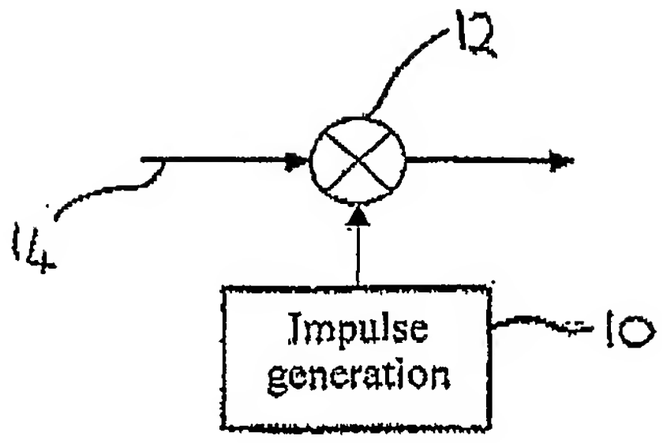
12
14
Impulse generation
10

Fig. 3(a)

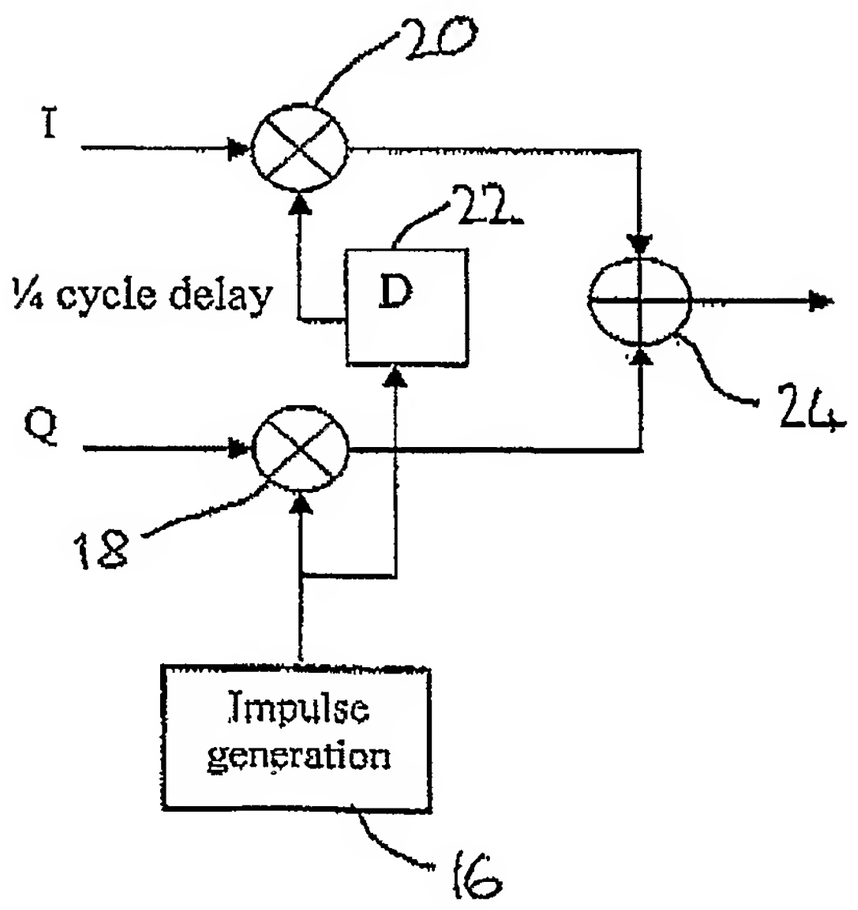
20
I
22
¼ cycle delay
D
24
Q
18
Impulse generation
16

Fig. 3(b)

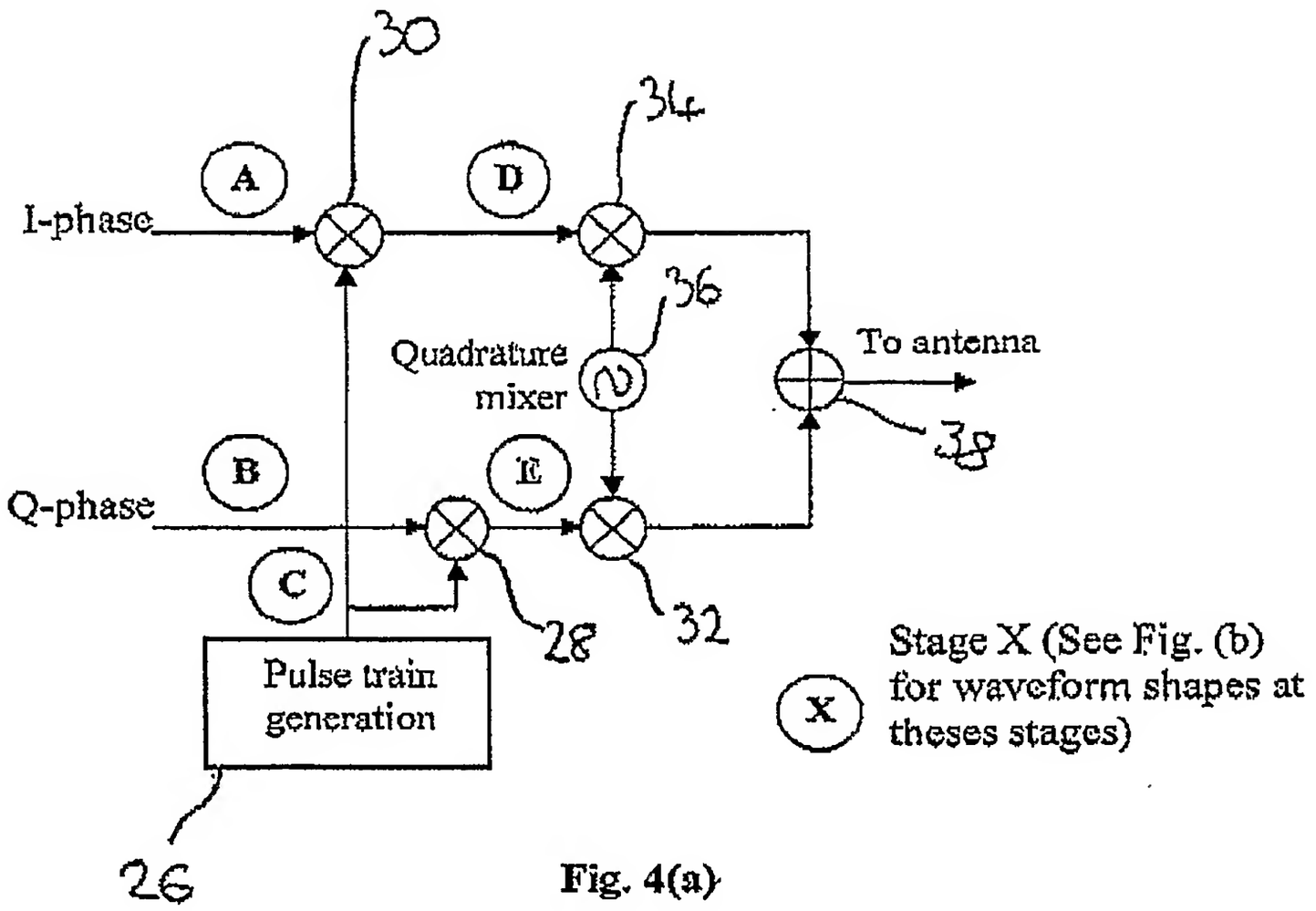
30
34
A
D
I-phase
36
Quadrature mixer
To antenna
38
B
E
Q-phase
C
28
32
Pulse train generation
26
X
Stage X (See Fig. (b) for waveform shapes at theses stages)

Fig. 4(a)

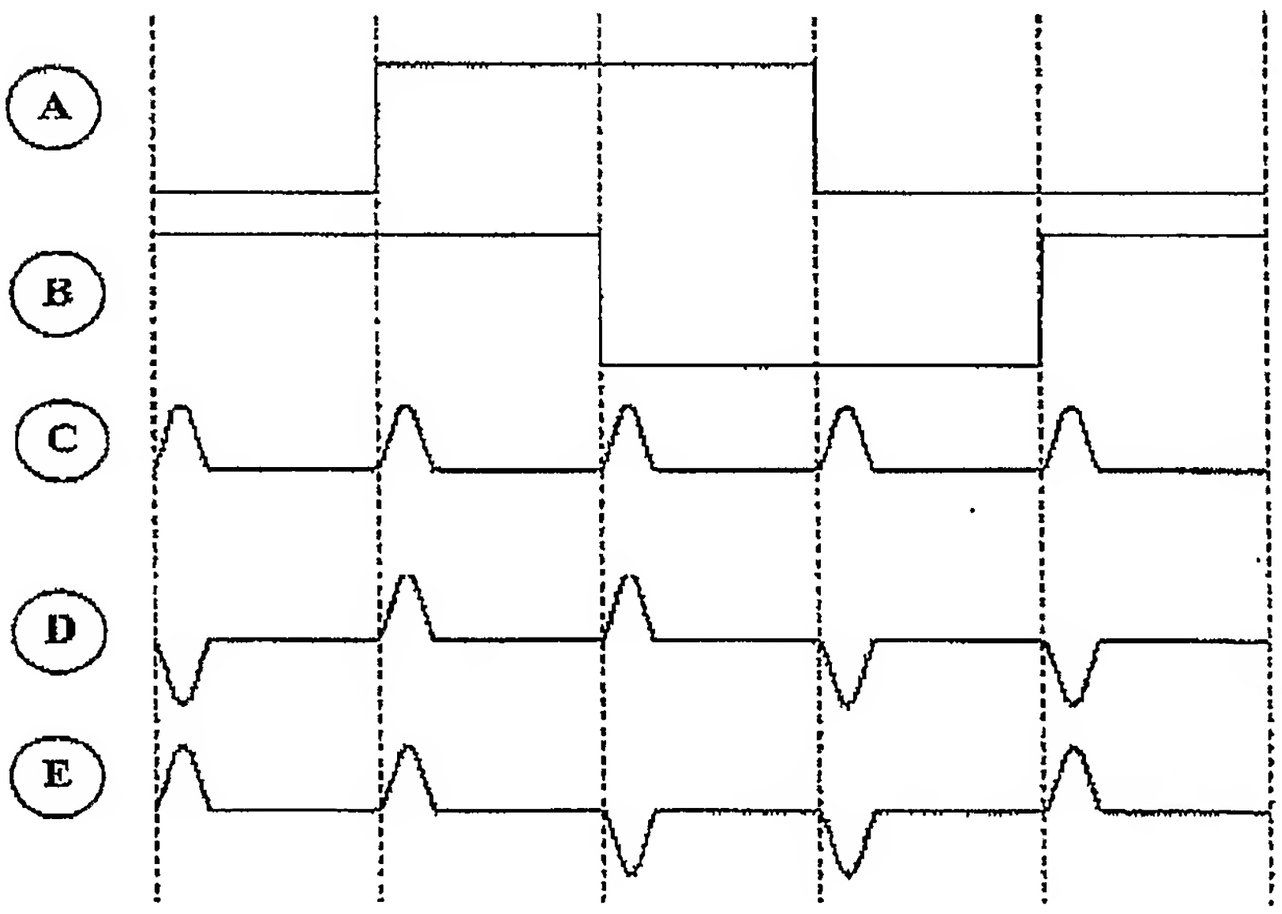
A
B
C
D
E

Fig. 4(b)

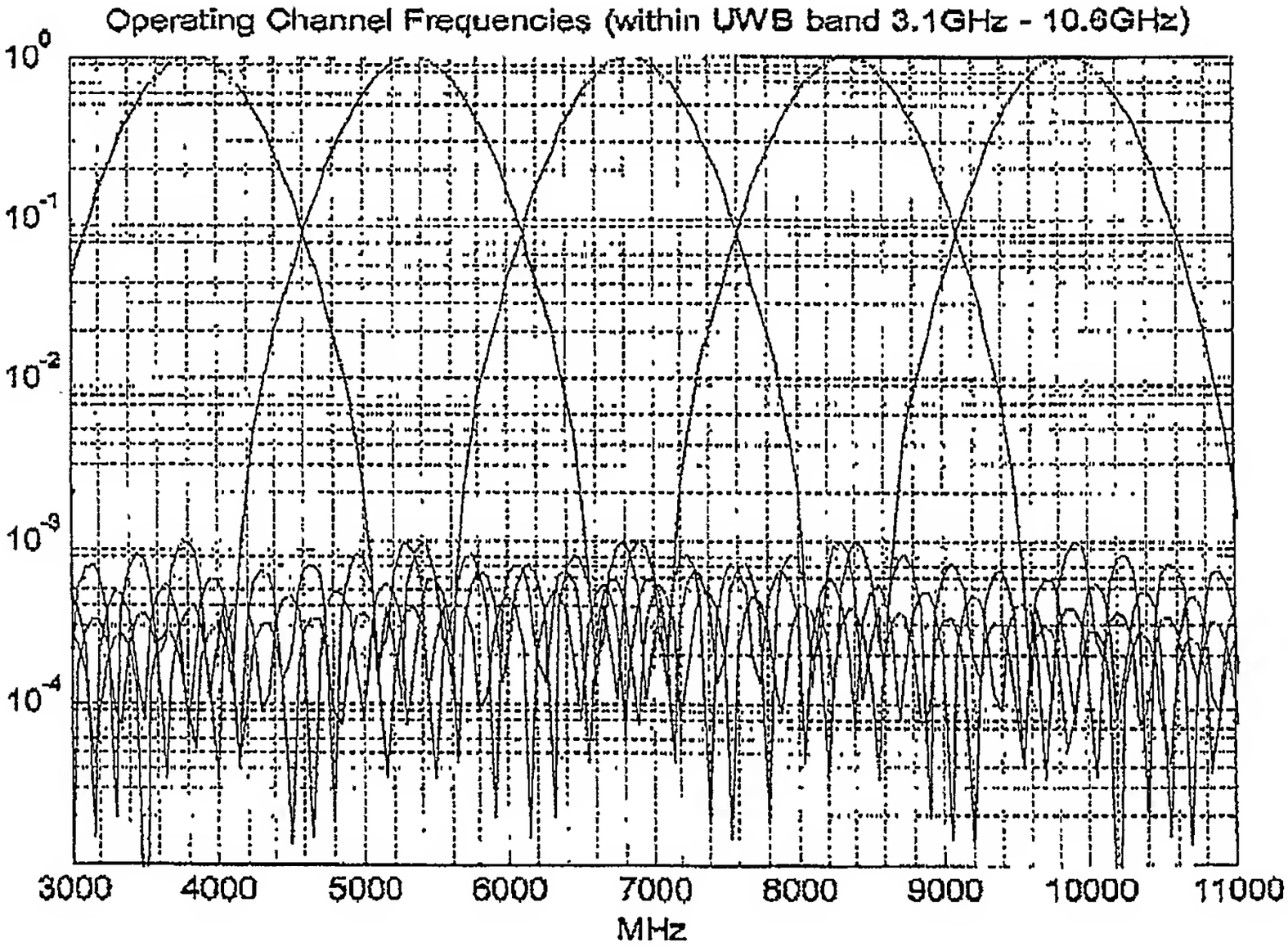
Operating Channel Frequencies (within UWB band 3.1GHz - 10.6GHz)
10^0
10^-1
10^-2
10^-3
10^-4
3000
4000
5000
6000
7000
8000
9000
10000
11000
MHz

Fig. 5

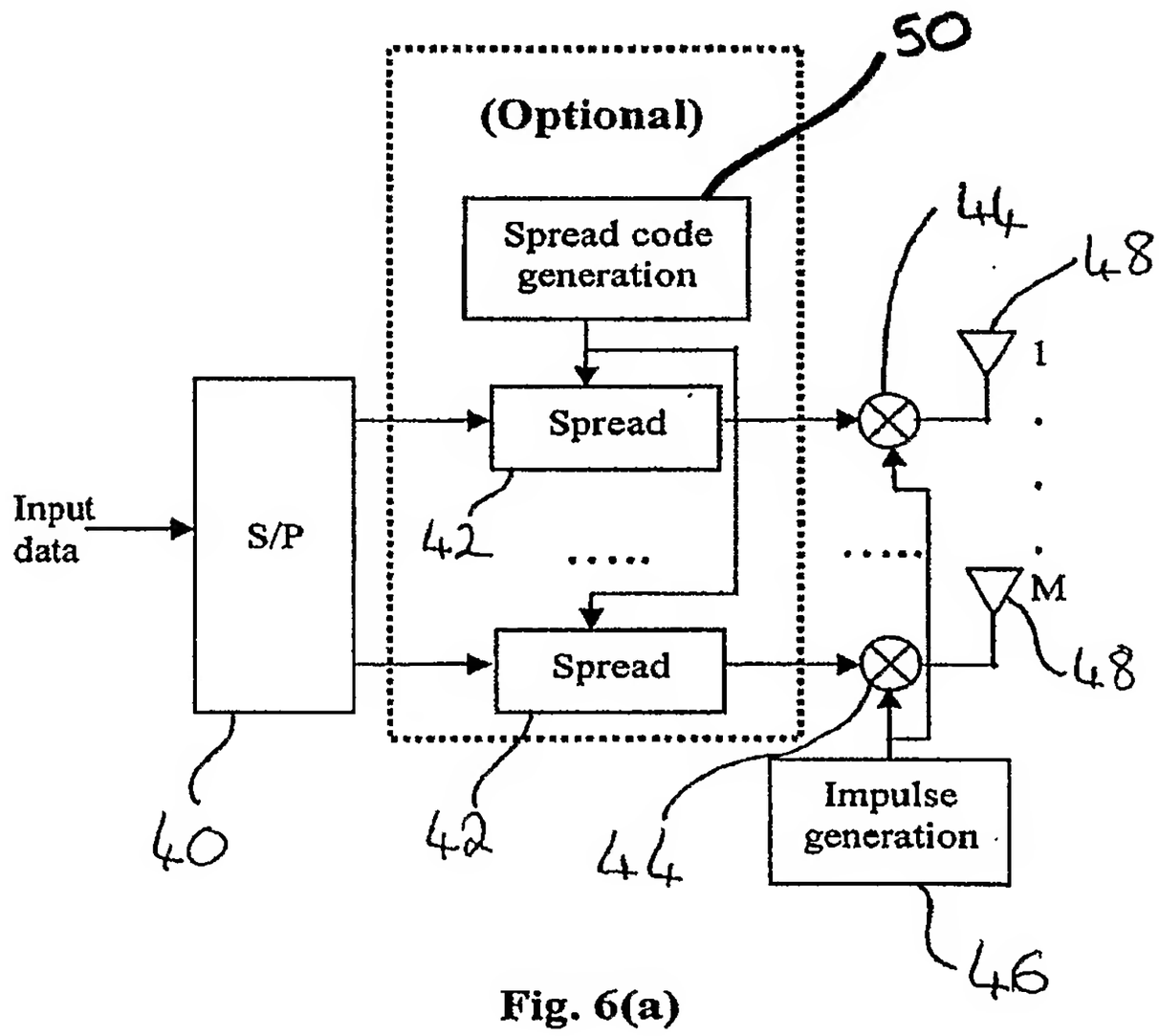
(Optional)
50
Spread code generation
44
48
1
Spread
Input data
S/P
42
.....
M
Spread
48
40
42
44
Impulse generation
46

Fig. 6(a)

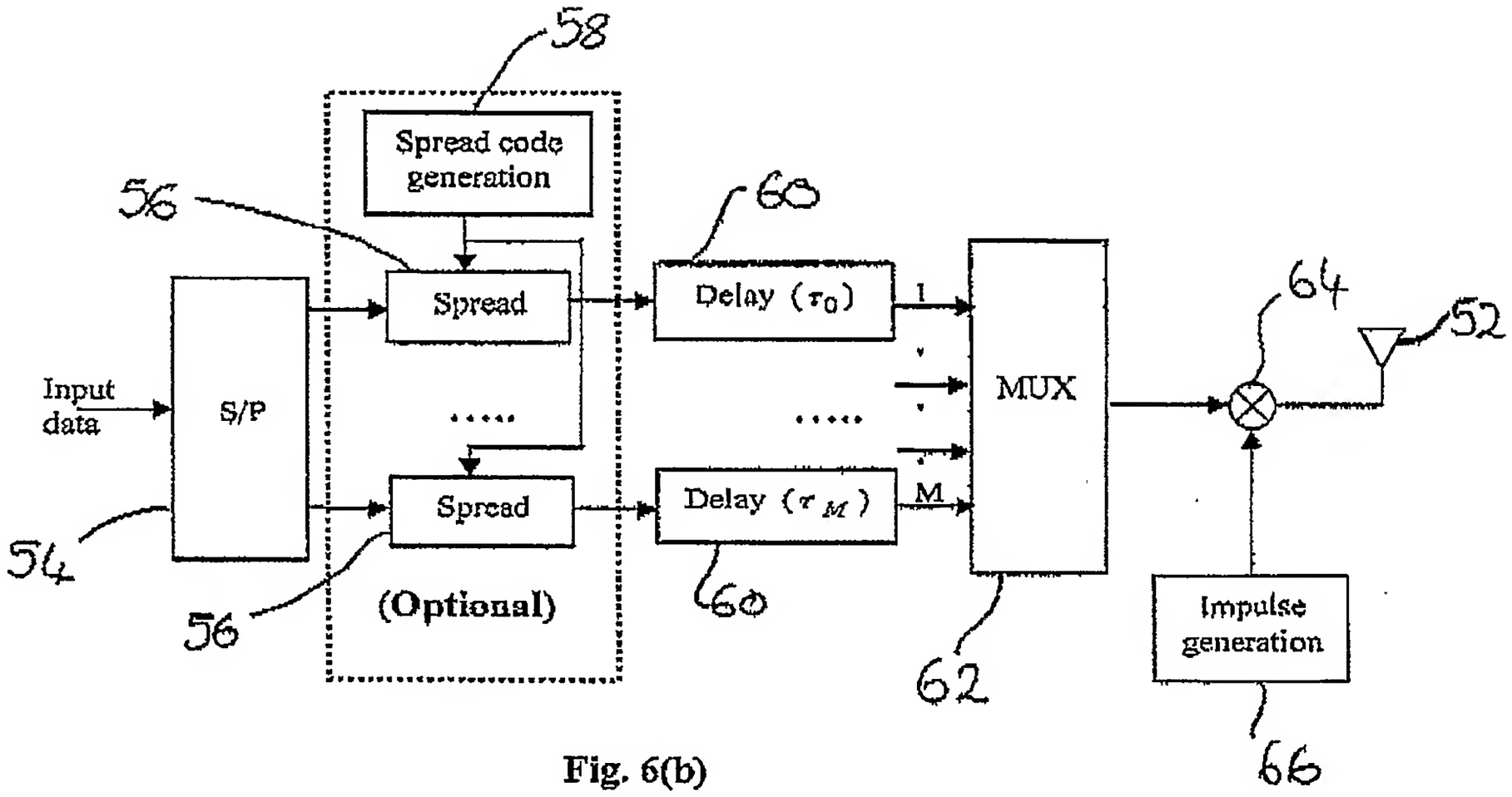
58
Spread code generation
56
60
Spread
Delay (τ_0)
1
64
52
Input data
S/P
.....
.....
MUX
Spread
Delay (τ_M)
M
54
56
(Optional)
60
62
Impulse generation
66

Fig. 6(b)

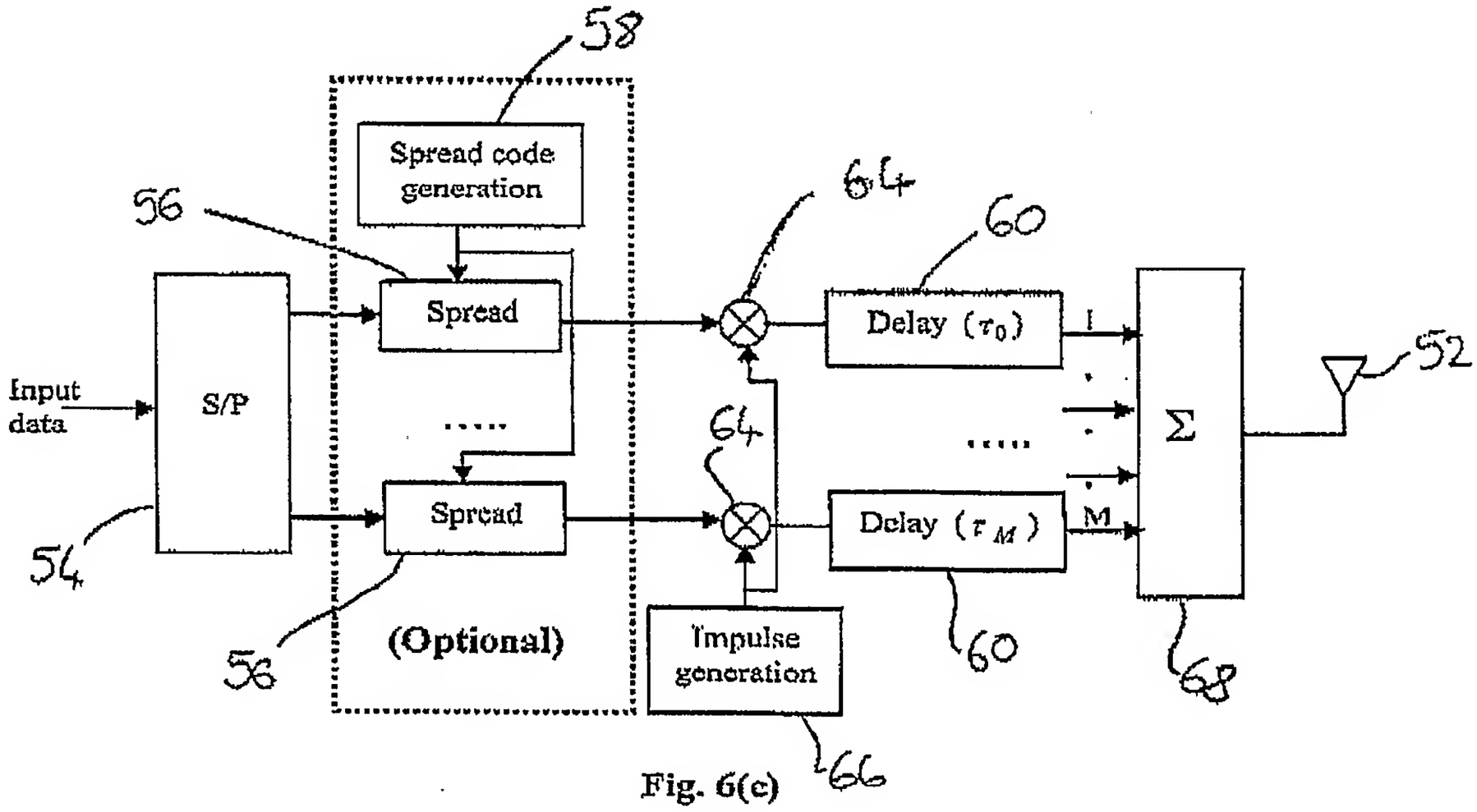
58
Spread code generation
56
64
60
Spread
Delay (τ_0)
1
52
Input data
S/P
.....
64
Σ
Spread
Delay (τ_M)
M
54
56
(Optional)
Impulse generation
60
68
66

Fig. 6(c)

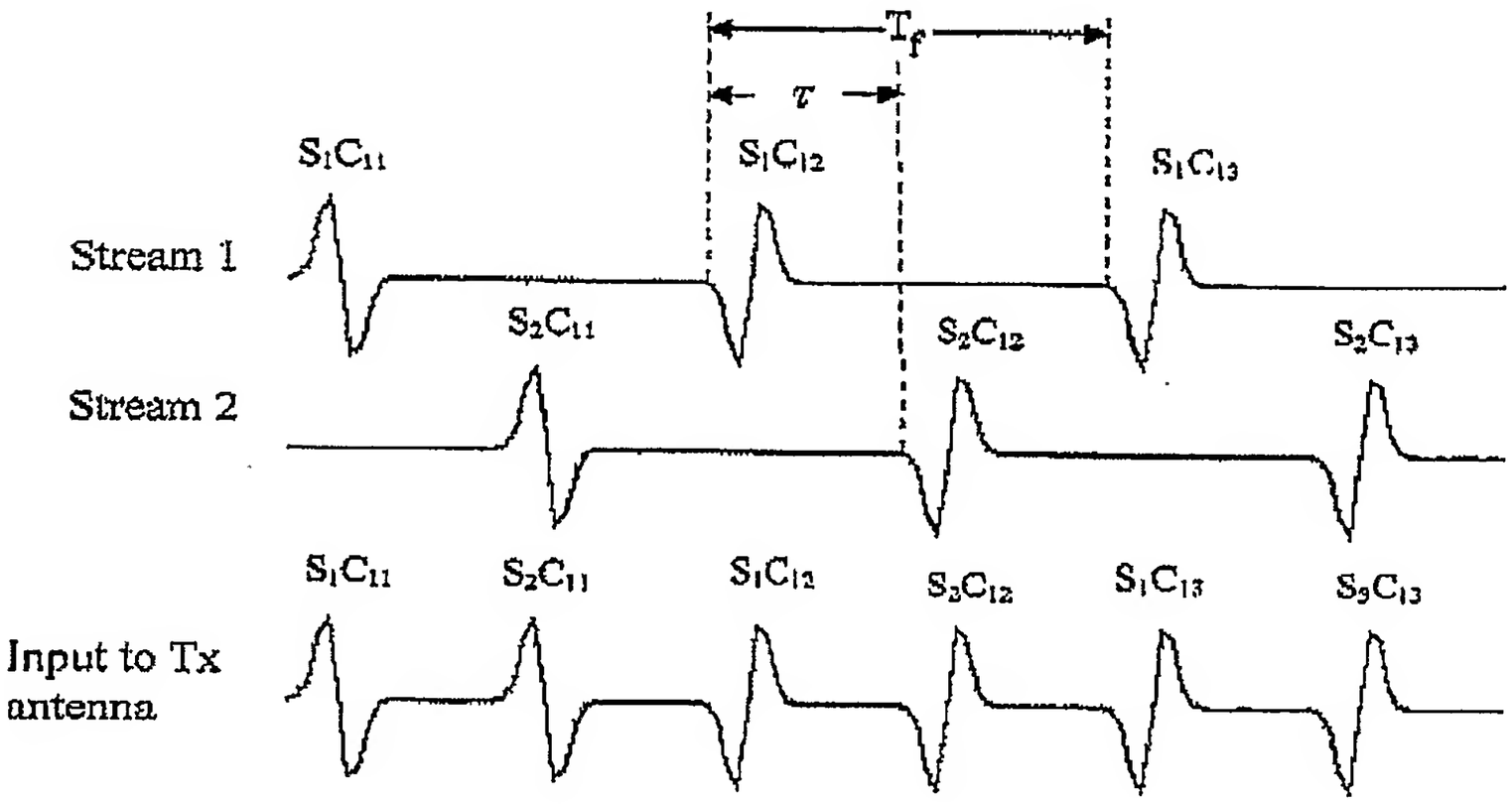
T_f
τ
S_1C_{11}
S_1C_{12}
S_1C_{13}
Stream 1
S_2C_{11}
S_2C_{12}
S_2C_{13}
Stream 2
S_1C_{11}
S_2C_{11}
S_1C_{12}
S_2C_{12}
S_1C_{13}
S_2C_{13}
Input to Tx antenna

Fig. 7

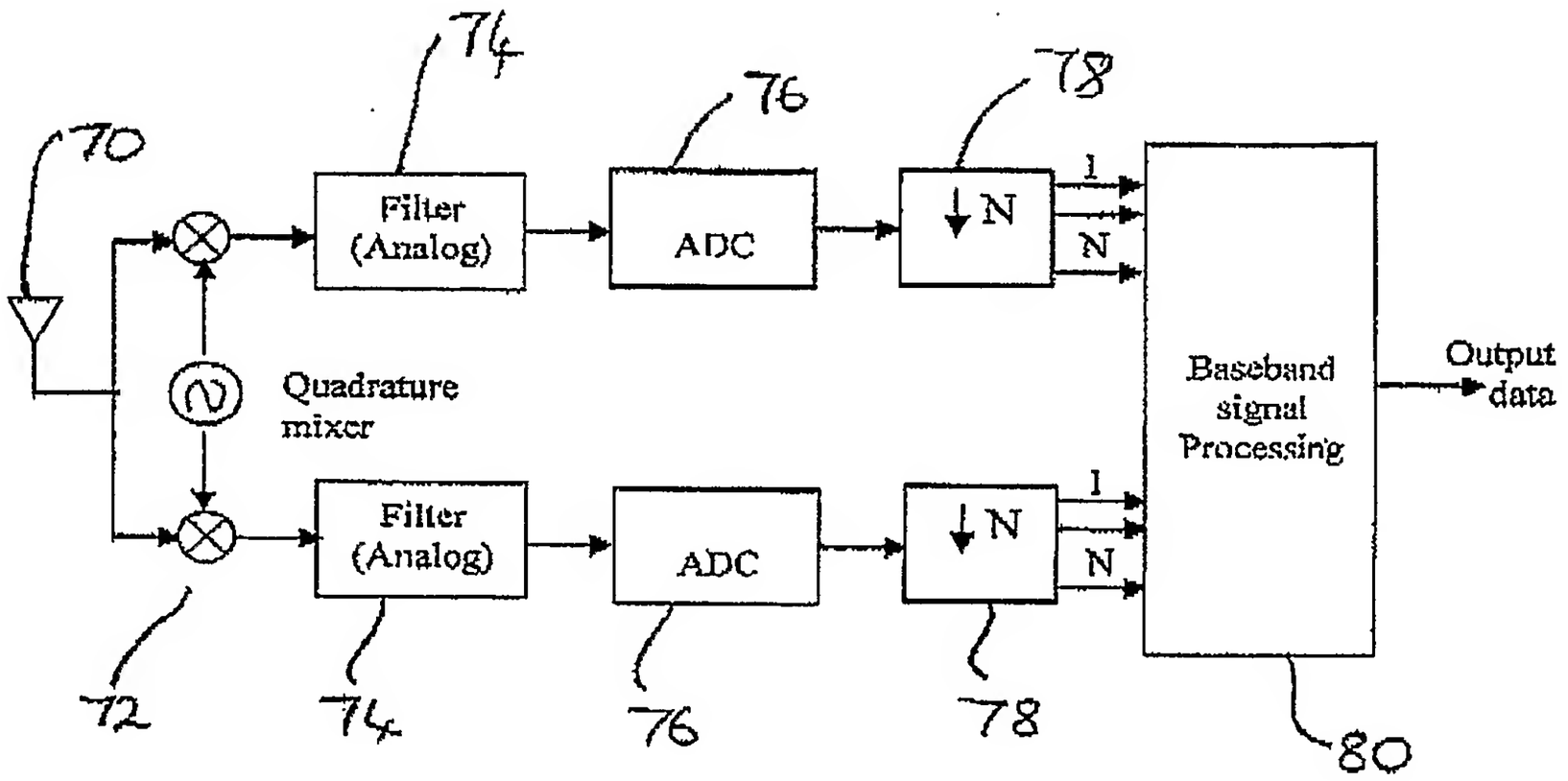
70
74
76
78
Filter (Analog)
ADC
↓N
1
N
Quadrature mixer
Baseband signal Processing
Output data
Filter (Analog)
ADC
↓N
1
N
72
74
76
78
80

Fig. 8

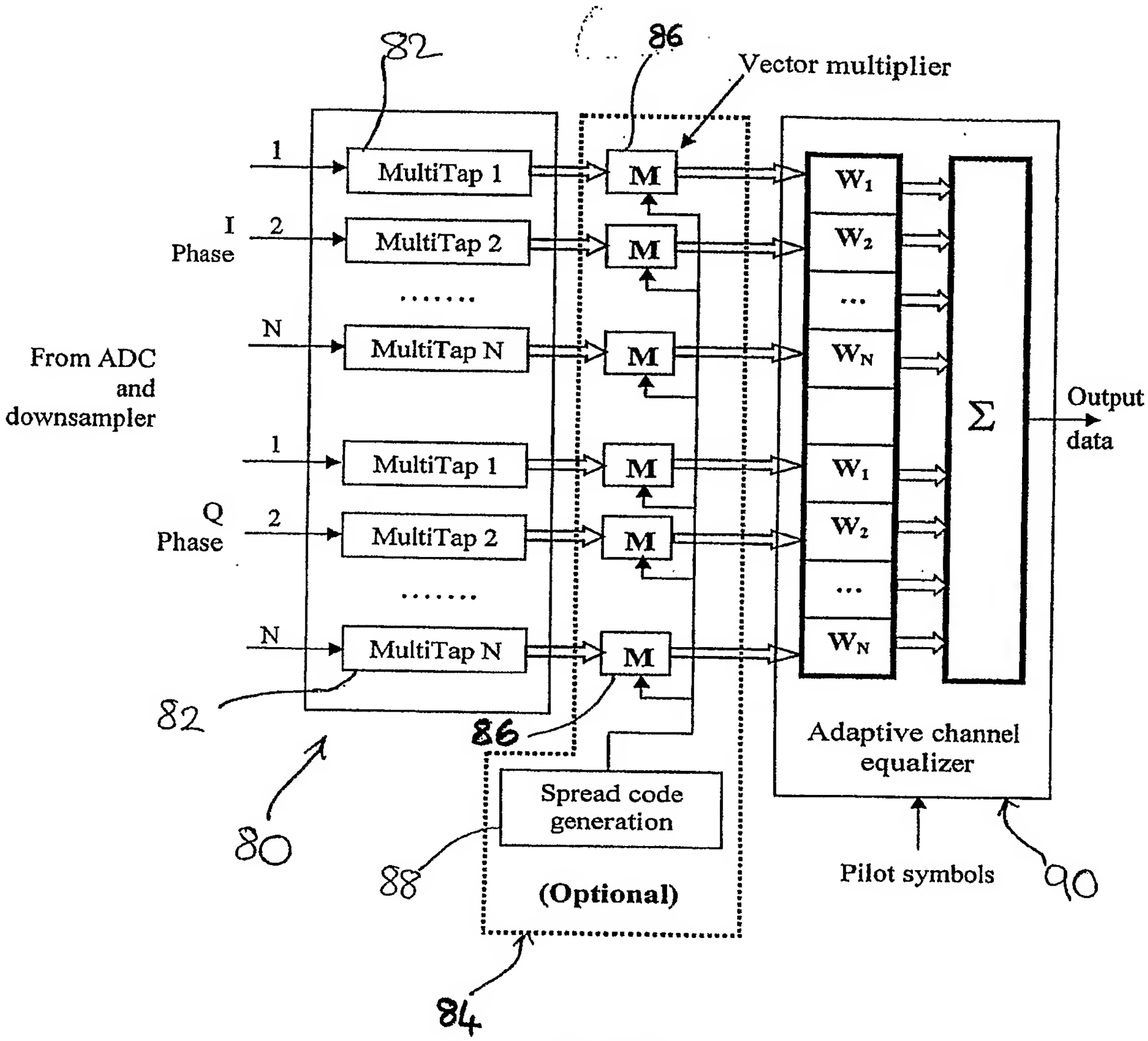
82
86
Vector multiplier
1
MultiTap 1
M
W1
I
Phase
2
MultiTap 2
M
W2
.....
...
N
MultiTap N
M
WN
From ADC
and
downsampler
Σ
Output
data
1
MultiTap 1
M
W1
Q
Phase
2
MultiTap 2
M
W2
.....
...
N
MultiTap N
M
WN
82
86
Adaptive channel
equalizer
80
Spread code
generation
88
(Optional)
Pilot symbols
90
84

Fig. 9(a)

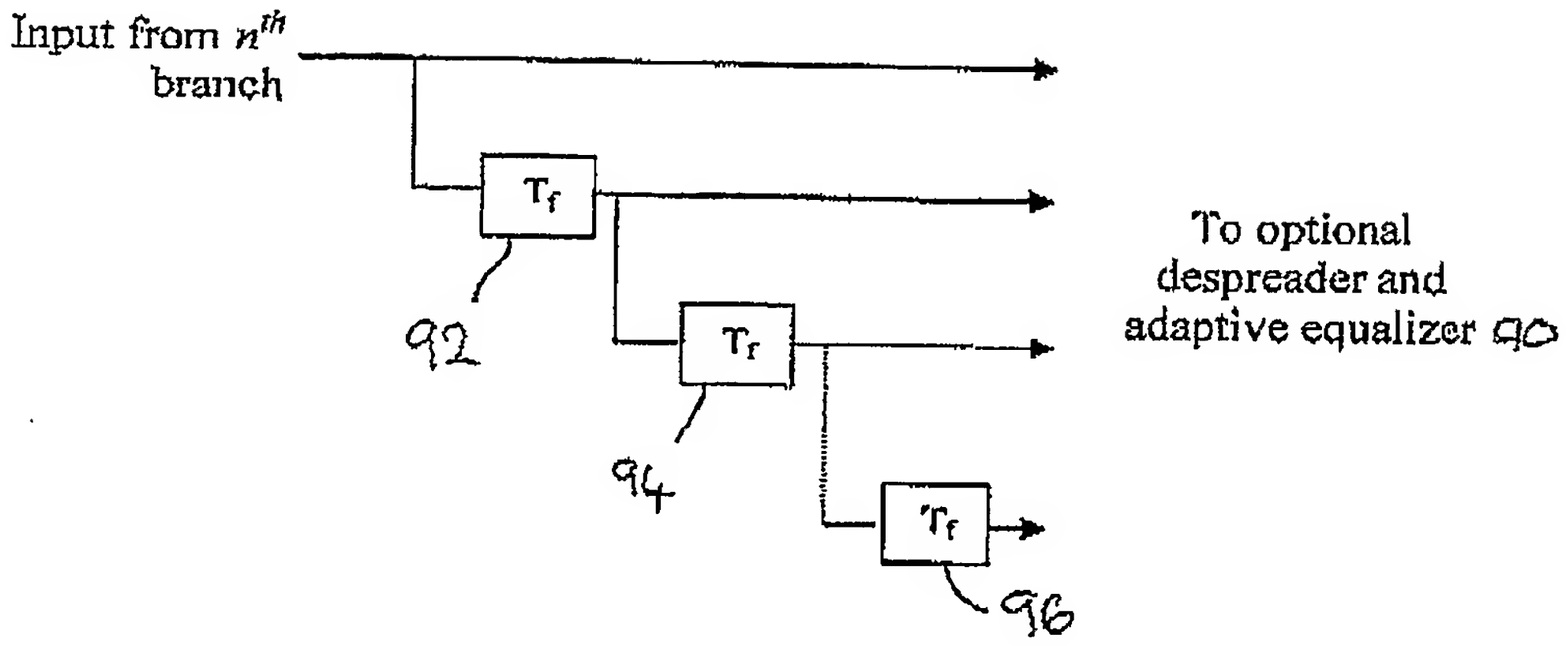
Input from n^{th} branch
T_f
92
T_r
94
T_f
96
To optional despreader and adaptive equalizer 90

Fig. 9(b)

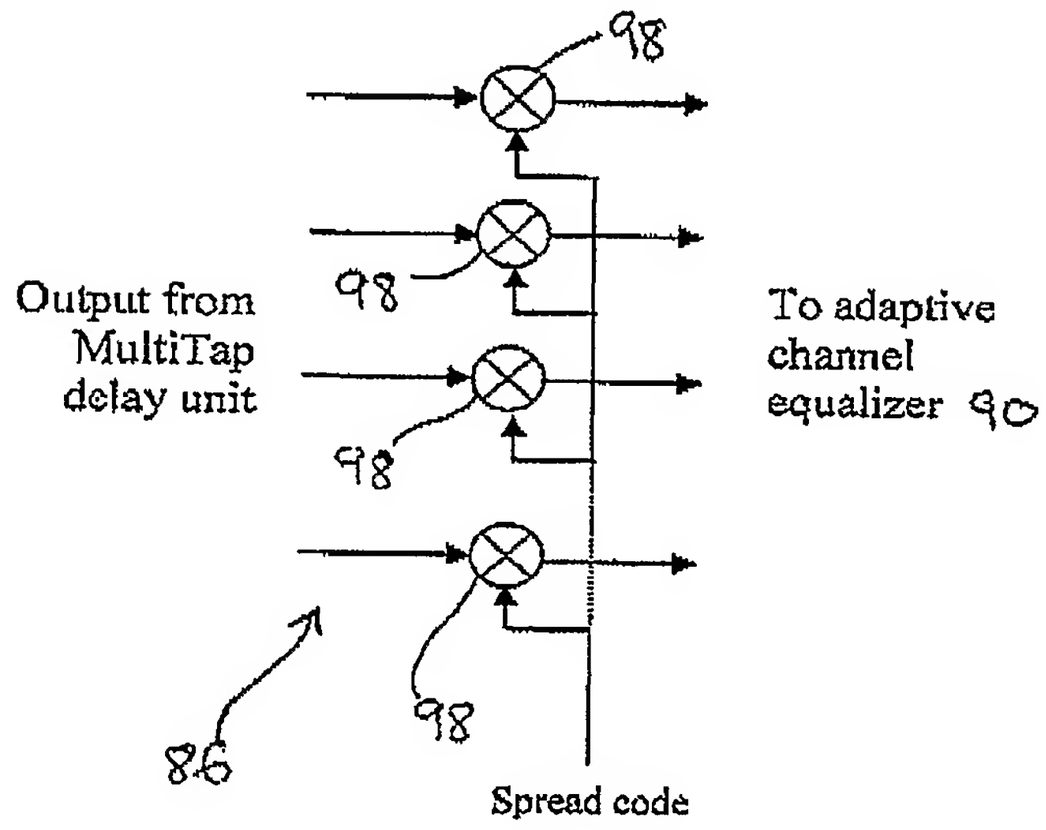
98
98
98
98
Output from MultiTap delay unit
To adaptive channel equalizer 90
86
Spread code

Fig. 9(c)

Target Channel Characteristics[5]	CM 1[1]	CM 2[2]	CM 3[3]	CM 4[4]
Mean excess delay (nsec) (τ_m)	5.05	10.38	14.18	
RMS delay (nsec) (τ_{rms})	5.28	8.03	14.28	25
Number of mulitpaths within 10 dB			35	
No of multipaths within 85% of energy	24	36.1	61.54	
Model Parameters				
Cluster arrival rate, Λ (1/nsec)	0.0233	0.4	0.0667	0.0667
Ray arrival rate, λ (1/nsec)	2.5	0.5	2.1	2.1
Cluster decay factor, Γ	7.1	5.5	14.00	24.00
Ray decay factor, γ	4.3	6.7	7.9	12
Standard deviation of cluster log-normal fading term, σ_1 (dB)	3.3941	3.3941	3.3941	3.3941
Standard deviation of ray log-normal fading term, σ_2 (dB)	3.3941	3.3941	3.3941	3.3941
Standard deviation of log-normal shadowing for all, σ_x (dB)	3	3	3	3
Model Characteristics[5]				
Mean excess delay (nsec) (τ_m)	4.9	9.4	13.8	26.8
RMS delay (nsec) (τ_{rms})	5	8	14	26
Number of multipaths within 10 dB	13.3	18.2	25.3	41.4
No of multipaths within 85% of energy	21.4	37.2	62.7	122.8
Channel energy mean (dB)	-0.5	0.1	0.2	0.1
Channel energy std (dB)	2.9	3.3	3.4	3.2

[1] This model is based on Line Of Sight (LOS) (0-4 meter) channel measurements.
[2] This model is based on Non-Line Of Sight (NLOS) (0-4meter) channel measurements.
[3] This model is based on NLOS (4-10 meter) channel measurements.
[4] This model was generated to fit a 25 nanoseconds RMS delay spread to represent an extreme NLOS multipath channel.
[5] These characteristics are based upon a 167 picoseconds sampling time.
(More details of these channel models are described in Channel Modeling Sub-Committee Final Report of IEEE P802.15 Working Group for Wireless Personal Area Networks, *Document No: IEEE P802.15-02/368r5-SG3a*, December 2002.

Fig. 10

Parameters	Values		
Data modulation (Dm)	QPSK		
No of Transmit data streams (Nx)	2		
LO Frequency	4 GHz		
ADC Sampling rate (Fs)	2 GHz		
No of bits/ADC	Floating point and one-bit ADC		
Oversampling factor (Os)	32	16	16
No of Delay taps	2	4	2
Pulse rate (Chip rate) (Pr = (Fs/Os)*Nx)	125 Mpps	250 Mpps	250 Mpps
Processing gain (G)	4 (Pilot), 1 (Data)		
Channel coding (R)	½		
Data Rate (Dr = (Pr/G)*R*Dm)	62.5 Mbps	125 Mbps	125 Mbps
Channel Equalization	RLS Equalizer		
Channel Models used	CM1 LOS (0-4M) and CM3 NOLS (4-10M)		

Fig. 11

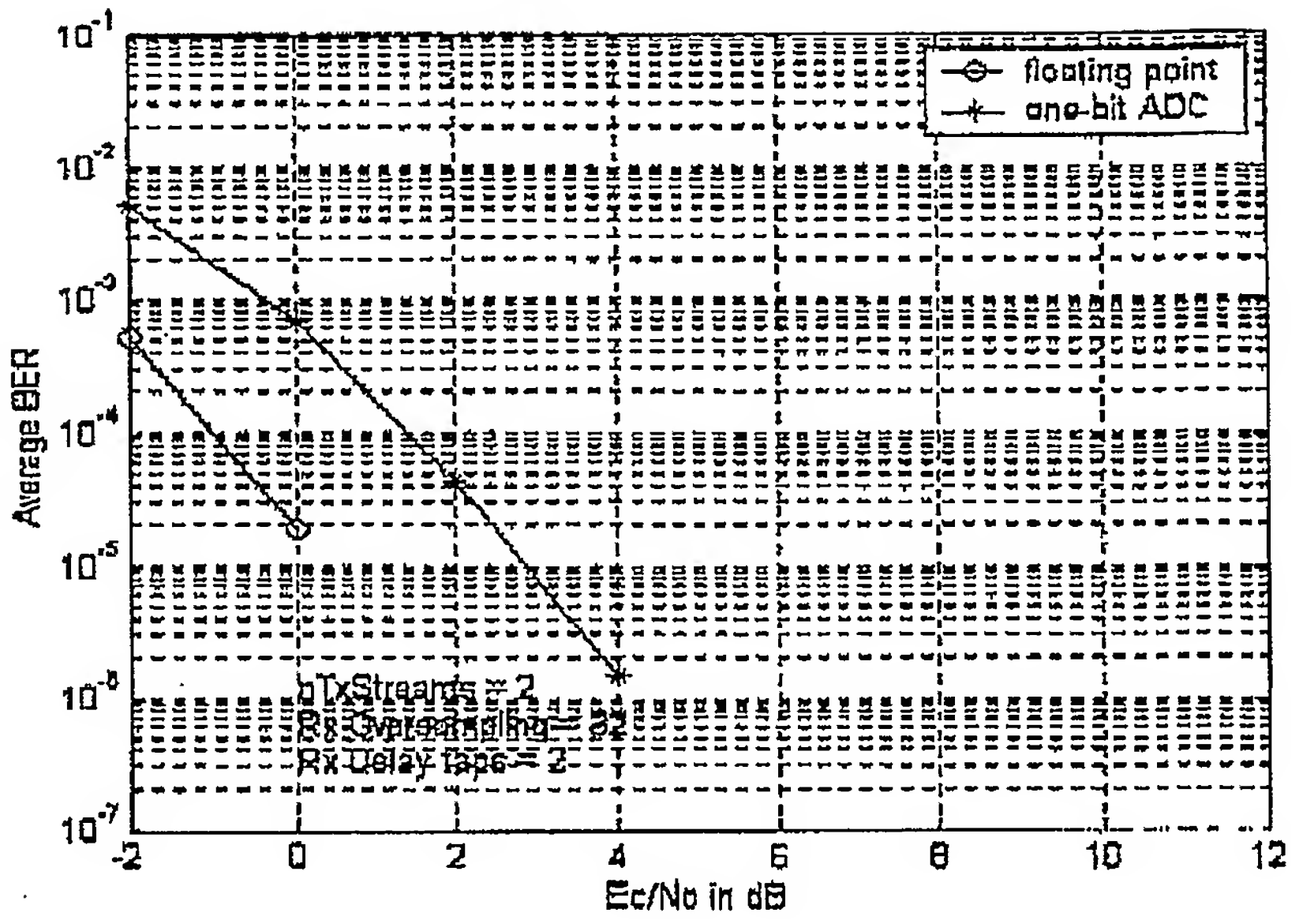

Fig. 12(a)

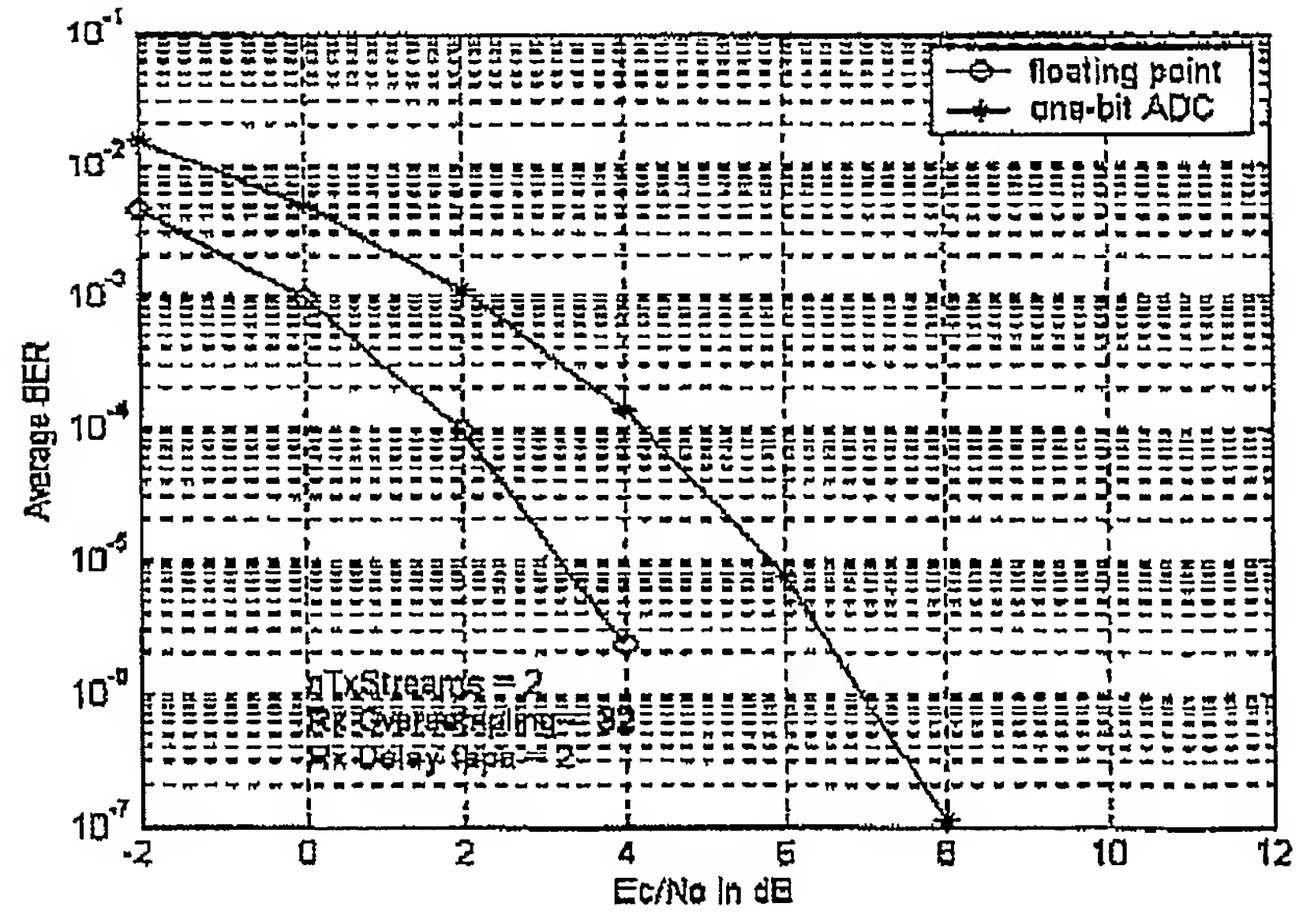

Fig. 12(b)

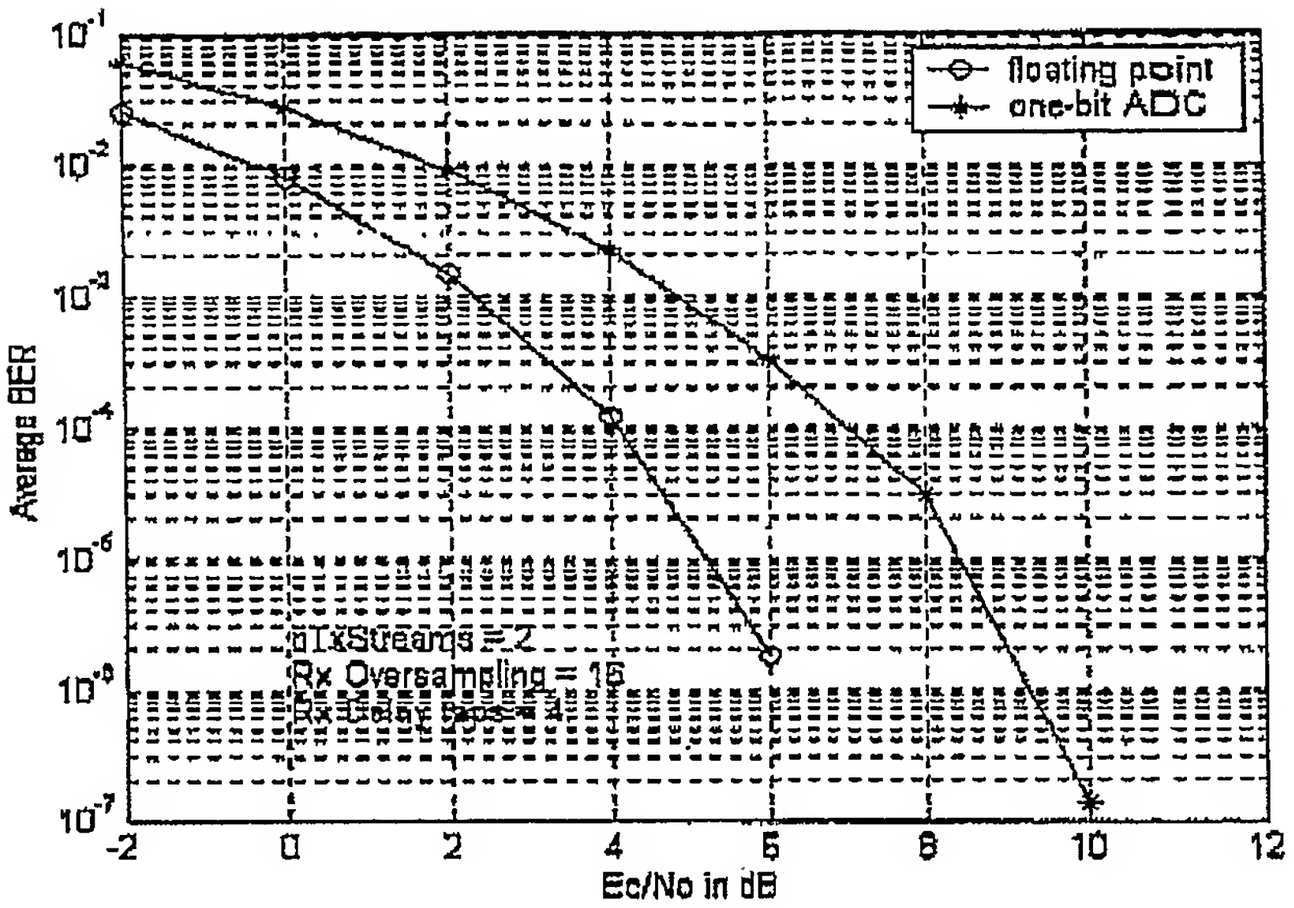

Fig. 13(a)

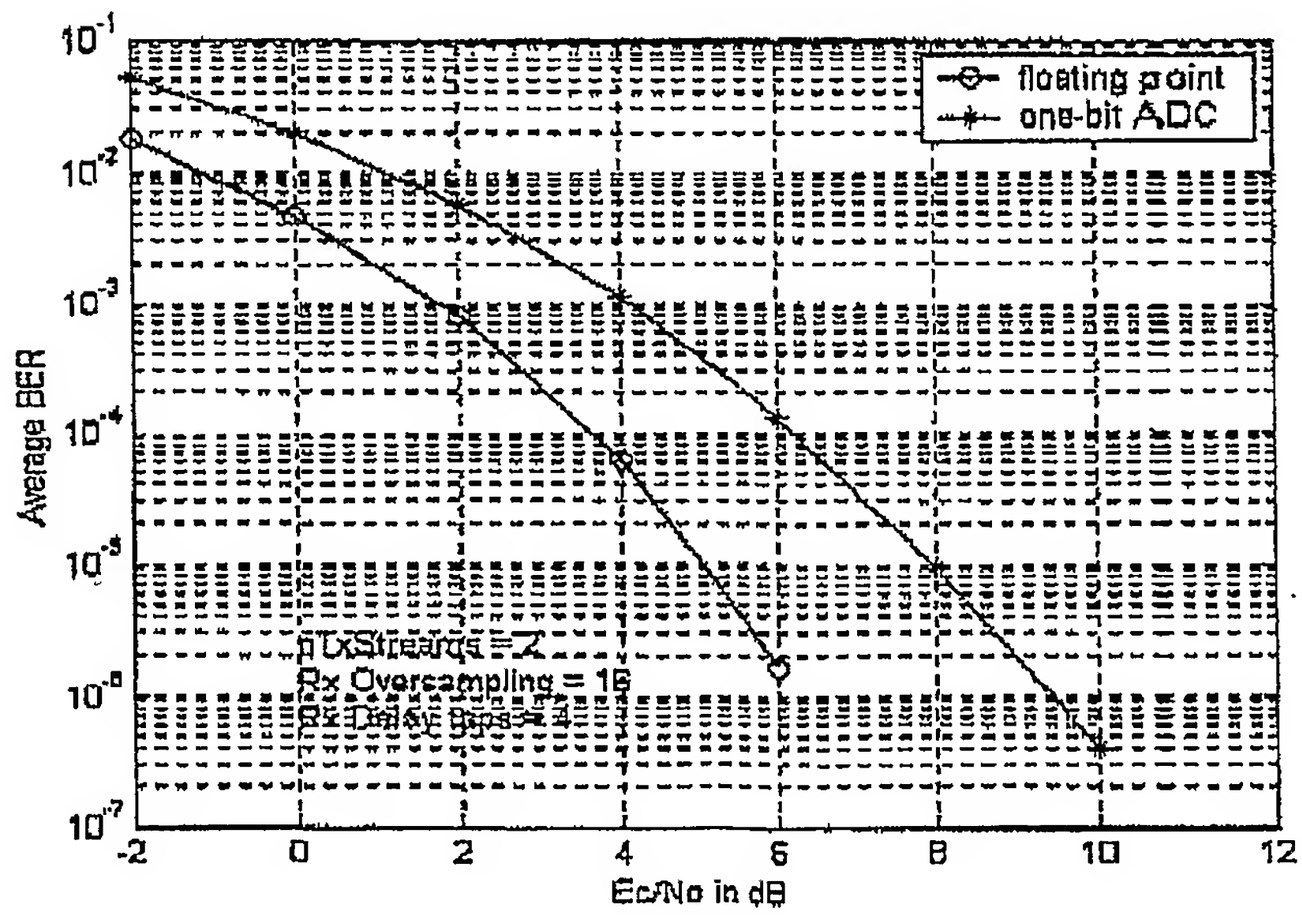

Fig. 13(b)

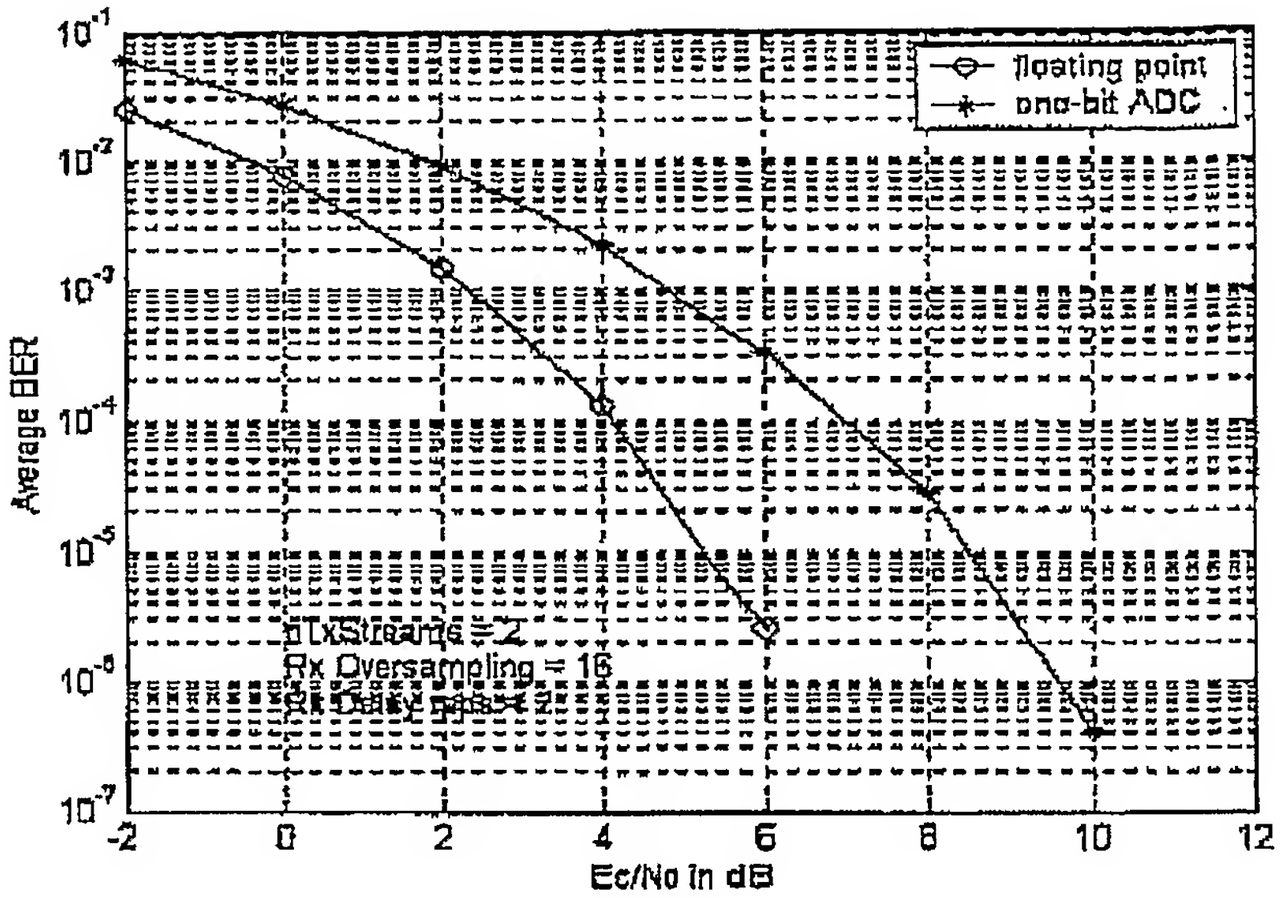

Fig. 14(a)

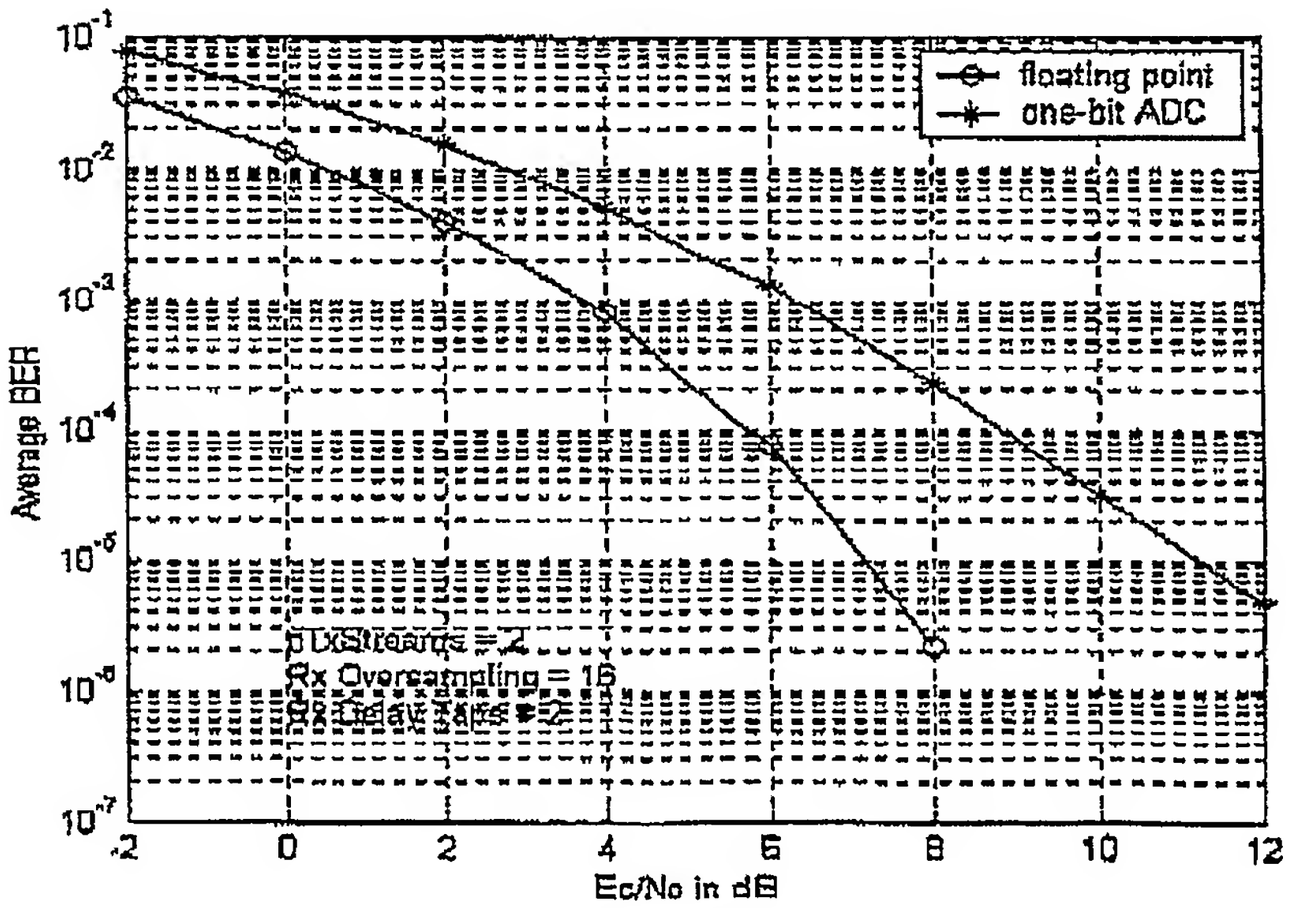

Fig. 14(b)

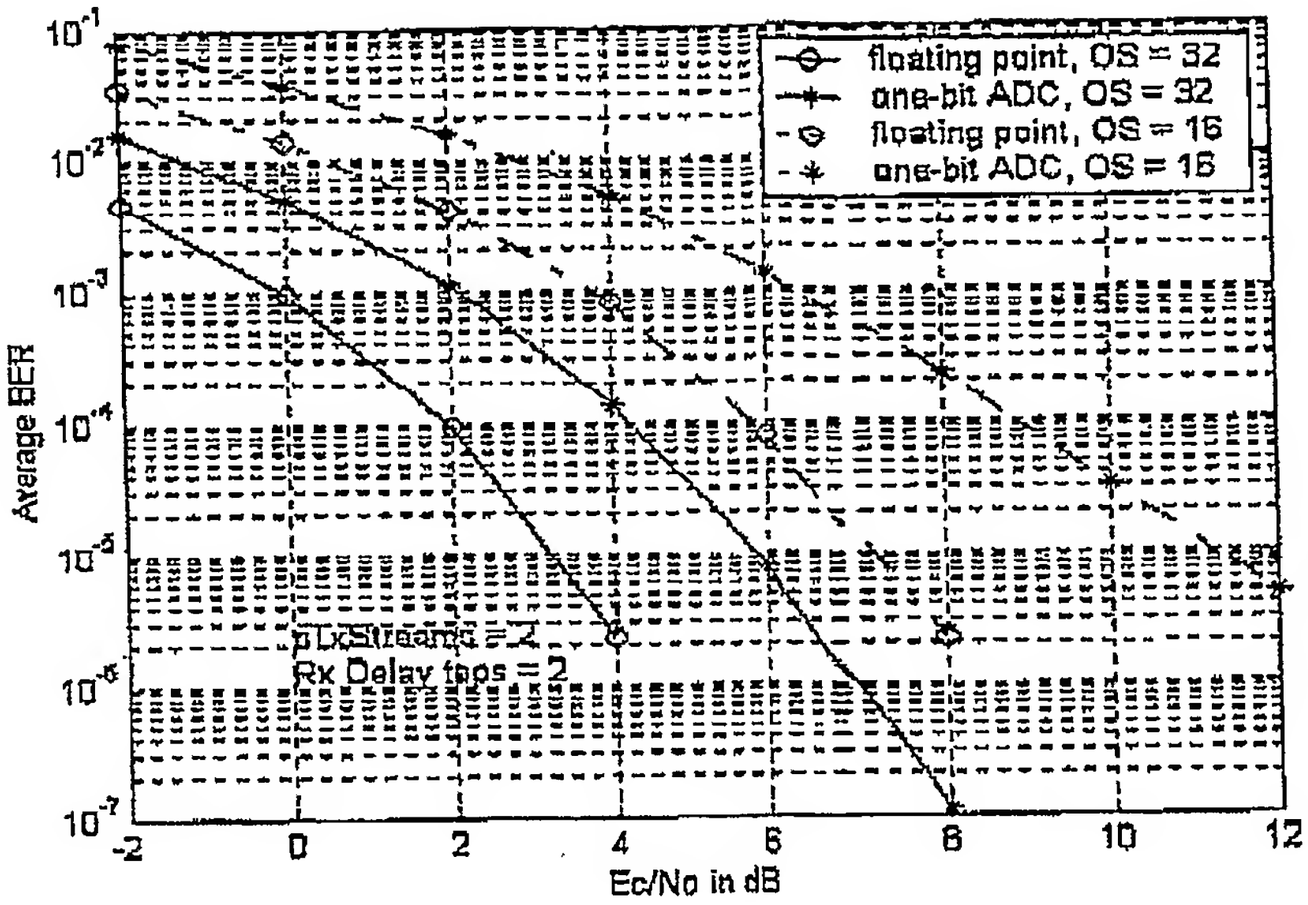

Fig. 15(a)

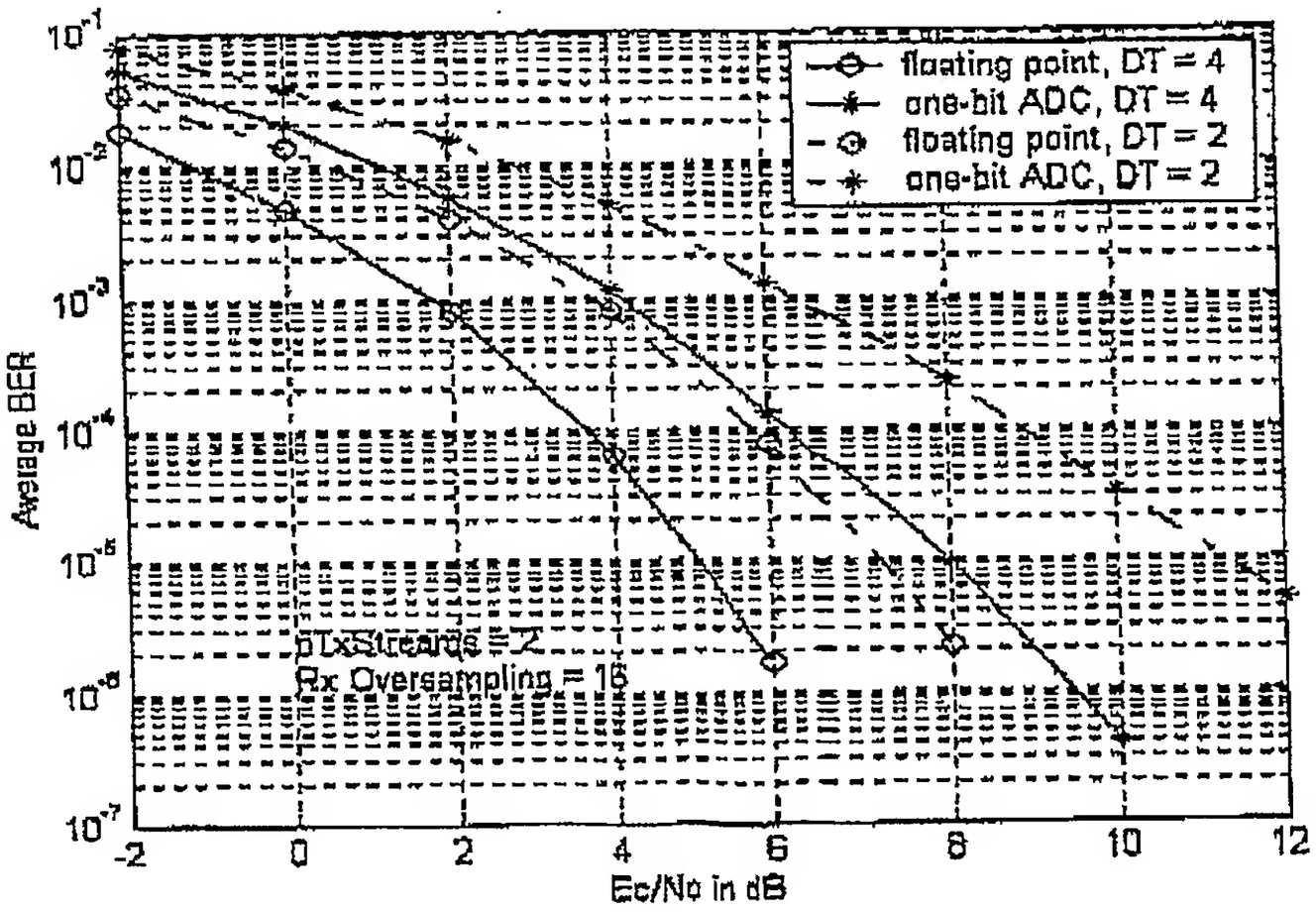

Fig. 15(b)